Toxic metals in European Ulva spp. – evaluation of potential use in food and feed applications

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Toxic metals in European *Ulva* spp.
– evaluation of potential use in food and feed applications

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Introduction

There is an increased interest in Europe to understand and evaluate the commercial potential of high-yielding European seaweed species such as *Ulva* spp. (European Commission, 2017). This study presents a literature analysis of the content of selected toxic trace metals in European *Ulva* spp. to assess its potential for application in the food or feed sector.

Data collection and analysis

The data of this study has been found through the Web of Science (September 2017) using the following keywords: (*Ulva* OR sea lettuce OR *Enteromorpha*) AND (metal* OR trace element* OR Hg OR mercury OR Iod* OR arsen* OR Pb OR Cd OR cadmium).

Only studies concerning the As-, Cd-, Pb- or Hg contents in *Ulva* spp. sampled from natural European populations were included in the study. In studies with several data points from samples from same location, only mean values were used.

Statistical analyses were performed with JMP 13.0.0 (SAS Inc.).

Results

In total 137 data points were extracted from 35 studies. The maximum concentrations of As, Cd, Pb and Hg were 22, 23.6, 748 and 2.2 mg/kg dry weight (DW), respectively. Average concentrations of the complete dataset of the study (Fig 1) and a dataset excluding contaminated sites (Figs 2-5) were evaluated with respect to EU maximum levels (European Parliament, 2015 and 2017). Only a few studies report of concentrations of inorganic arsenic (iAs), but a mean value of 0.057 ± 0.023 mg/kg DW was found for samples from the Mediterranean Sea.

Table 1. Mean contents of toxic metals in wild European *Ulva* spp. collected at non-contaminated sites and European maximum levels for food and feed.

Metals	Mean contents in European *Ulva* spp. (mg/kgDW)	Maximum levels (European Parliament, 2015 & 2017)	
		Food (mg/kgWW)	Feed (mg/kg relative to a moisture content of 12 %)
iAs	0.1 (N=7)	0.1-0.3 [a]	<2 [b]
As	5.55 (N=27)	No level defined	40 [b]
Cd	0.81 (N=96)	3 [c]	0.5 [d]
Pb	7.32 (N=96)	0.3-3 [e]	5-10 [f]
Hg	0.15 (N=35)	0.5-1 [g]	0.1-0.5 [h]

[a] different rice products, [b] feed materials derived from seaweed, [c] food supplements from dried seaweed, [d] complementary or complete feed, [e] leaf vegetables or food supplements, [f] complete feed or complementary feed, [g] fishery products, [h] any feed material or fishery products.
Abbreviations: dry weight (DW), wet weight (WW).

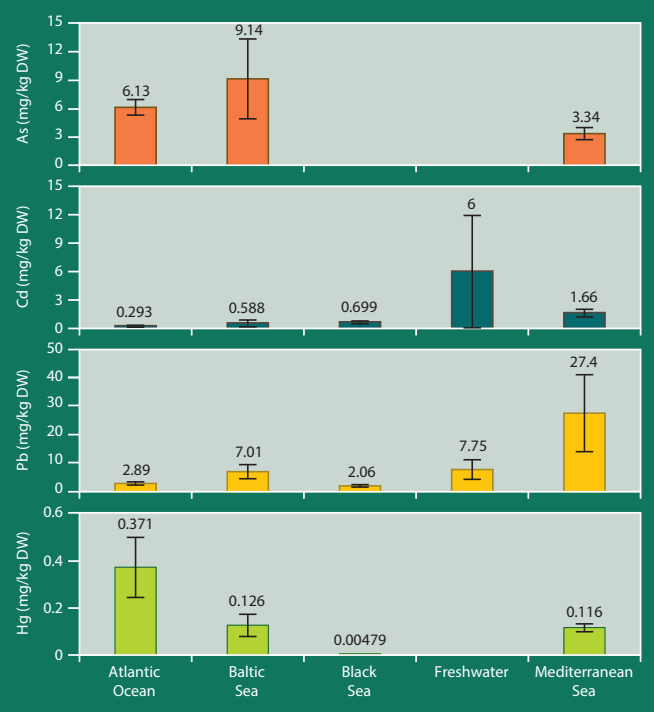

Figure 1. Concentrations of As. Cd. Pb and Hg in samples of wild European *Ulva* spp. from different marine areas and freshwater (AV±SE).

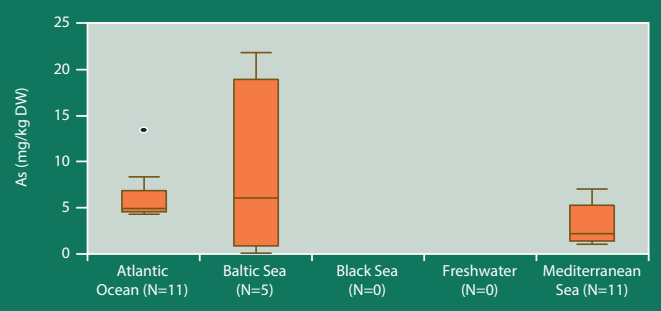

Figure 2. Arsenic concentration in wild European *Ulva* spp. from different non-contaminated marine areas and freshwater (interquartile ranges and outliers).

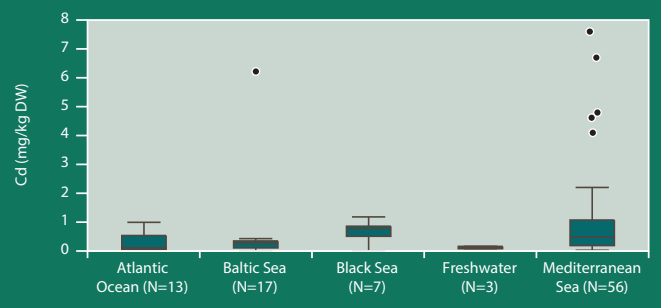

Figure 3. Cadmium concentrations in wild European *Ulva* spp. from different non-contaminated marine areas and freshwater (interquartile ranges and outliers).

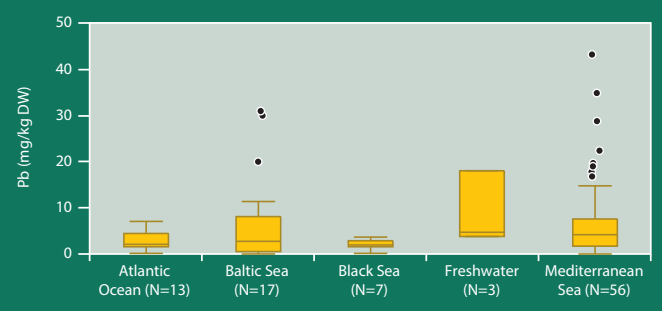

Figure 4. Lead concentrations in wild European *Ulva* spp. from different non-contaminated marine areas and freshwater (Interquartile ranges and outliers).

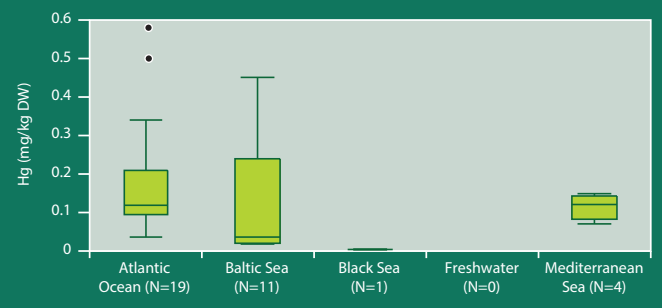

Figure 5. Mercury concentrations in wild European *Ulva* spp. from different non-contaminated marine areas and freshwater (interquartile ranges and outliers).

Discussion and concluding remarks

Concentrations of total As, iAs and Cd in European *Ulva* spp. sampled at non-contaminated areas do not exceed the EU maximum levels. In contrast, concentrations of Pb and Hg exceeding the maximum levels have been reported, which could potentially limit the potential use of European *Ulva* spp. in food and/or feed applications. Further investigations are needed to further understand the factors that influence the concentration of toxic metals in *Ulva* spp.

Acknowledgements
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